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The effect of Ginger *(Zingiber officinale*) on weight loss and lipid profile in obese rats

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Abstract

For the last decades, obesity has become a serious health issue risking the population's health worldwide. Obesity can be defined as abnormal or excessive fat accumulation that leads to several health risks such as type 2 diabetes, hypertension, cardiovascular diseases, certain cancers, and severely disabling musculoskeletal disorders, which are among the world's leading causes of death and morbidity. In fact, most countries around the world are currently overweight and obese. The high rates of obesity in the Kingdom of Saudi Arabia (KSA), which led to the urgent need to lose weight, so it is necessary to resort to balanced diets and away from the use of drugs to reduce weight, such as systems that depend on natural products such as ginger. Zingiber is utilized in cosmetics, nutraceuticals, and medicines. A combination of volatile (zingiberene), non-volatile (oleoresin), and phenolic chemicals can be found in ginger (gingerol and shogaol, zingerone and paradol). Biological studies by researchers showed that ginger is characterized by **its anti-obesity** effectiveness as well as its anti-high blood fat. Since the dawn of time, ginger and other medicinal herbs have been used to treat a variety of illnesses. The goal of this research report is to learn more about the effects of ginger on weight loss and lipid profile. So, for this purpose, the qualitative method was applied, which relies on secondary data sources. Additionally, a range of research that had been conducted by other researchers was used.

Keywords: Ginger, Obesity, cholesterol, Triglyceride, weight loss

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INTRODUCTION

Obesity occurs because of an energy imbalance between caloric intake and expenditure. The resulting energy excess and associated weight gain are caused by a complex interaction between genetics, environment, economics, and individual behaviors Worldwide, more than 2.1 billion people are overweight or obese. In the United States nearly 35% of adults are classified as obese and one-third of children and adolescents are obese or overweight, Obesity prevalence in KSA has risen dramatically in recent years as a result of increased fast-food consumption, increased use of autos, elevators, escalators, remote controls, and increased consumption of sugary beverages Obesity and overweight are on the rise in KSA, particularly among women, and are well-known risk factors for coronary artery disease. The gathered information from 17,232 Saudi households with people aged 30 to 70 to perform a national epidemiological health study According to the survey, the prevalence of overweight and obesity in Saudi Arabia is 36.9% and 35.5%, respectively. While women are more likely to be obese than males, men are considered to be significantly more overweight **(Ahmed et al., 2014).** Despite this relatively simplistic definition, obesity is a multifactorial disease that results from chronic positive energy balance, i.e., when dietary energy intake exceeds energy expenditure. Excess energy is converted to triglyceride which is stored in adipose tissue depots that expand in size, thereby increasing body fat and causing weight gain **(Kristy Brahui et al., 2016)**. Obesity is a health problem in many countries, and it is an excessive or abnormal accumulation of fat that harms the health of the individual **(WHO, 2021).** A diet with high-calorie content and a lack of vegetables and fruits can contribute to obesity **(MOH, 2018).** Other factors such as high calorie drinks and fast food, and consumption of excess amount of food can lead to obesity and weight gain **(Mayo Clinic, 2020).** Obesity, measured by a rise in body mass index (BMI), is a serious health issue caused by insufficient physical activity and excessive food consumption **(Obaroakpo et al., 2020).** The prevalence of obesity is rapidly increasing worldwide across both genders and all ages **(Blüher, 2019).** It is estimated that during the next decades, prevalence of obesity in Saudi Arabia will rise from its current rate of 24.7% **(Althumiri et al., 2021).** Yet, obesity is an independent risk factor for developing type-2 diabetes mellitus (T2DM) and metabolic syndrome **(Luci et al., 2020).**

Historical and geographical view

Ginger has a long history of use and is a fantastic, spicy spice. The Muslim tradition records its Holy Book claims that by 650 AD, the people of Arabia were experts in ginger science. The biggest nation in the world is India. The manufacturer of this herb, which is used in Indian and Chinese food. Traditional medicines have been used for 5000 years **(Park et al., 2006).** A perennial monocot rhizome of the Zingiberaceae family, ginger (*Zingiber officinale*) is a native of south-east Asia. It is commonly used as a spice and a beverage flavoring, primarily in Asian products, throughout the world. Ginger is employed in traditional Asian medicine as well as in food. Based on the fact that India and China have historically utilized ginger to treat asthma, headaches, and infectious disorders, it has been used as traditional medicine for 2500 years to treat stomach problems, colds, and headaches **(Pushpalatha and Shakir, 2022).** Fig.1. explains the Taxonomical classification of Zingiber officinale

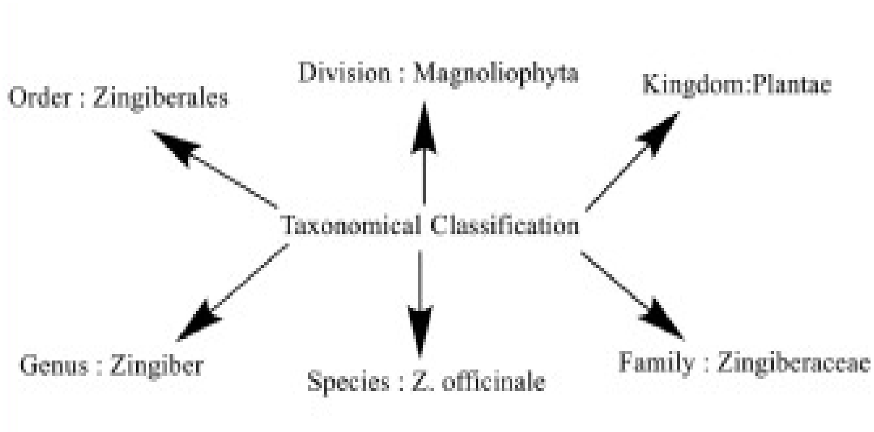

Figure 1. Taxonomical classification of Zingiber officinale

Chemical and nutritional components of ginger

Location, season, timing of harvest, methods of extraction, etc. all affect the nutritional content of ginger. The biochemical examination of the fresh or dried roots showed that they are a rich source of starch 60%, and additionally, it was discovered that the estimated moisture content was 9.80%, 4.2% fibers, 3.2% protein, 9.0% lipids and 3.12% in carbohydrates **(Bijaya, 2018).**

Ginger contains significant amounts of fiber, ash, and important minerals like calcium, nickel, salt, potassium, iron, magnesium, and copper. Numerous vitamins, including riboflavin, thiamine, niacin, and ascorbic acid, are also present in ginger. It also contains a lot of necessary and non-essential amino acids in addition to its nutritional benefits. Ginger includes sulfonoids and polyphenols, as well as poly- phenols and related compounds **(Abdul Qadir et al., 2017).**

Additionally, a plant's distinctive flavor is mostly a result of the gingérol molecule, a polyphenol that contains Depending on the drying conditions; gingérol's hydroxy-4-méthoxy-3 functional group can be changed to shogaol or paradol **(Yan et al., 2019).**

Pharmacological and therapeutic effects of ginger

There have been numerous reports of this plant's pharmacological and therapeutic effects, including: Inhibiting the manufacture of Cytocones that cause inflammation, such Interleukin 1 beta (IL-1B) and - Tumor Necrosis Factor (TNF), which has been shown in several clinical studies to be an effective method for treating inflammatory symptoms, and the study conducted by **Naheed et al., 2019**. In addition to rheumatoid arthritis, and helminthiasis, numerous research has focused on the health advantages of ginger use. Its anti-inflammatory, anti-tumor, anti-hyperglycemic, and anti-lipidemic properties have the most significant impact. By controlling the expression of enzymes involved in cholesterol homeostasis," gingerol", one of its bioactive substances, inhibits hyperlipidemia brought on by diets high in lipids, Ginger is regarded as a secure and powerful anti-diabetic **(Pushpalatha and Shakir,2022)**.

Ginger selectively inhibits the growth of ovarian cancer cells **(Farnaz Shokri et al., 2017)**. According to the findings **(Halima et al., 2020),** ginger supplements were effective in reducing menstrual pain and the discomfort associated with dysmenorrhea. It is considered the most effective high content of vitamin B6 as an anti-nausea during pregnancy **(Mehrnaz et al., 2018).** Furthermore, ginger had a protective effect against the toxicity of Di-(2-ethylhexylphthalate (DEHP) **(Fayrouz et al., 2019).** Fig.2. shows the mechanism of action of antioxidants in ginger

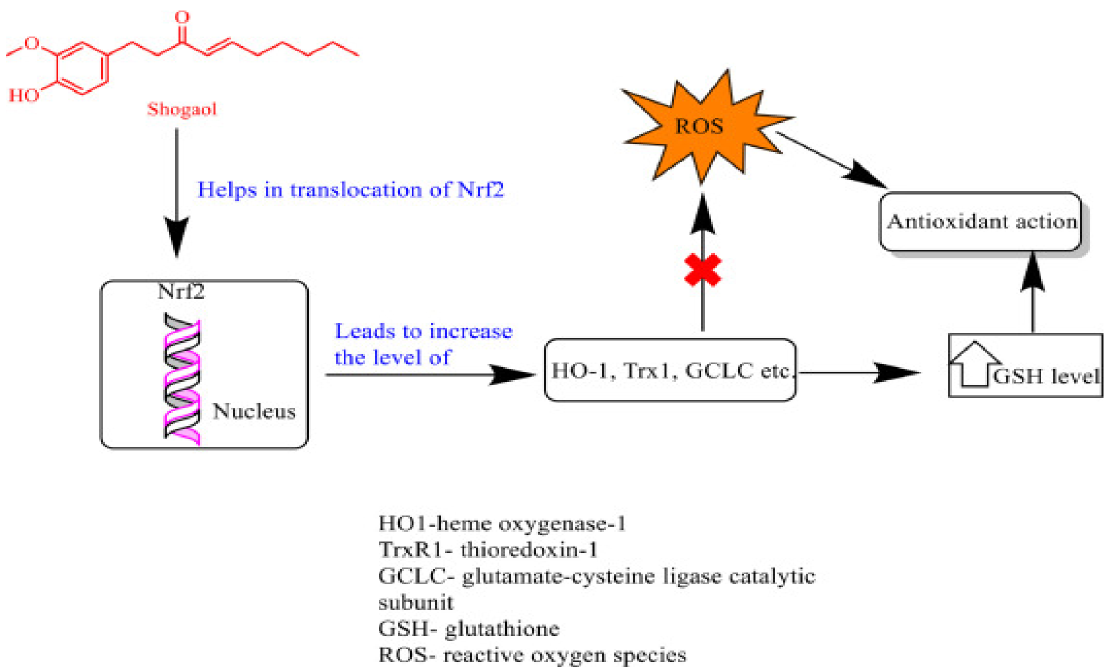

Fig.2. Mechanism of action of antioxidants in ginger

Ginger's effectiveness, toxicity, and safety

The US Food and Drug Administration (US FDA) considers ginger to be safe, **G**enerally **R**ecognized **as S**afe, (GRAS) because it has no harmful effects. The dose and toxicity of ginger have been checked and recommended by various earlier investigators.

In light of its safety, ginger administration is advised because it is associated with a noticeably superior 12-month prognosis in ovarian cancer patients receiving chemotherapy. According to a study in this area, ginger powder doses of 0.5–1.0 g taken twice weekly for periods ranging from three months to two and a half years had no negative effects. Animal studies revealed that doses of 2.5 grams/kg body weight were tolerated without causing any deaths. However, there was 10–30% mortality when the dose was increased to 3-3.5 g/kg body weight. An important study has shown that administering ginger extract to pregnant rats for 10 days throughout the organogenesis stage at varied concentrations, such as 100, 333, and 1000 mg/kg, did not produce any developmental or maternal harm. Another study was carried out in male and female rats for 35 days at dosages of 500, 1000, and 2000 mg/kg body weight. The findings showed that chronic ginger treatment was not linked to any fatalities or abnormalities in general health, behavior, growth, or food and water intake **(Zaman et al., 2017).**

Effects of Ginger on weight and lipid profile

Ginger is a natural anti-obesity because it is full of antioxidants including phenols and flavones, which are crucial in lowering levels of lipid profiles, serum glucose and liver enzymes **(Omyma and Mahmoud, 2016),** Fig 3. explains this.

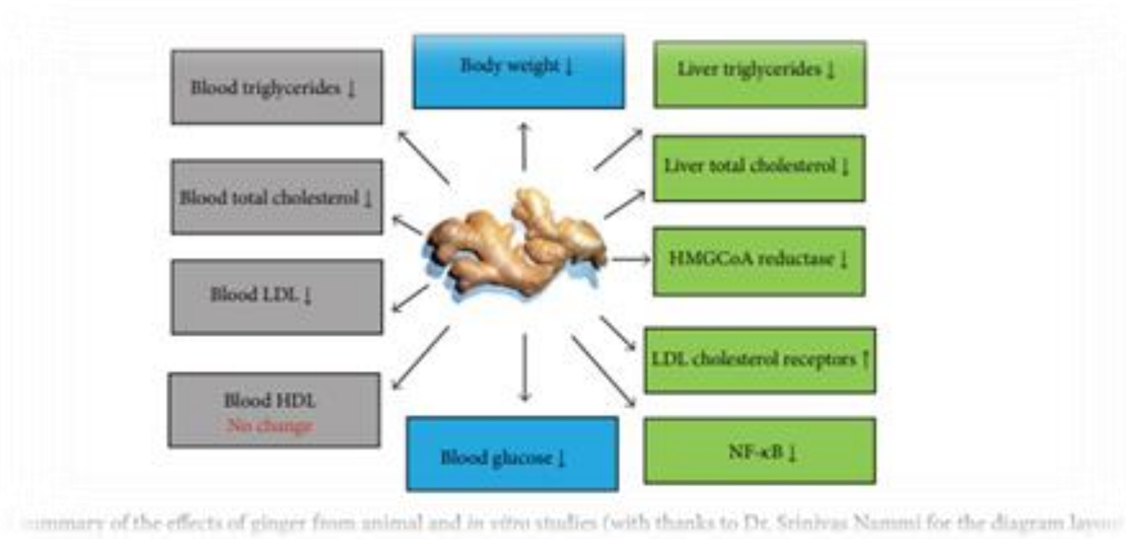

Fig.3.A summary of the effects of the ginger from animal and in vitro studies

The purpose of this research was to investigate ginger's potential role in promoting weight reduction and improving lipid profiles. Because of this, the qualitative approach was used, which makes use of secondary sources of information. A wide variety of other scholars' prior work also had been drawn on.

MATERIALS AND METHODS

Animals and food

Mice at 6 weeks of age were randomly assigned to one of three experimental groups that were fed different diets as desired for 7 weeks: low-fat diet (LF), high-fat diet (HF), and HF diet mixed with 5% powder ginger/kg(G). For the HF + G diet, cellulose was replaced with. The AIN93G diet was used to control, the LF diet, and the HF diet formula was adapted from a typical 60% calorie-fat diet Daily food intake was measured for each rat for 3 days in the last week of feeding. Body weight (BW) was monitored every week throughout the study. Body weight gain for each experimental group was calculated by subtracting the body weight before the start of the experiment from the final body weight (%) with the area under the curve (AUC). The feed efficiency ratio (FER, %) was obtained.

After completion of the experiment, animals were fasted for 12 h and sacrificed by carbon dioxide anesthetics. Blood was collected from a hole in the heart. Total cholesterol (TC, mg/dL) was measure in serum and liver and also analyzed. Fasting glucose concentration (mg/dL) was measured using a blood glucose meter.

In another research randomized double-blind placebo-controlled clinical trial was implemented among 50 overweight women. Participants were randomly divided into 2 groups. Group A received dietary supplements containing 125 mg green tea, 25 mg capsaicin and 50 mg ginger extracts (n = 25) group B received placebos (n = 25) twice with lunch and twice with dinner daily for 8 weeks. Then, body weight (BW) serum insulin concentrations and glutathione (GSH) were monitored. Other research Three diets, low fat high fat (HF, and high fat with 5% ginger powder in the food (HF + G), were randomly given to C57BL/6 male mice for seven weeks. In comparison to the LF diet-fed group, the HF diet resulted in higher levels of fasting hyperglycemia, total cholesterol, and hepatic lipids. Without changing dietary consumption, ginger supplementation significantly reduced HF-diet-induced BW gain, hyperglycemia, hypercholesterolemia, and hepatic steatosis. Another study of the effect of ginger and flaxseed on obese experimental rats. The findings showed a significant decrease in the rate of weight gain in mice from 43.5 g to 37.25 g respectively.

RESULTS AND DISCUSSION

Ginger supplementation ameliorated HF-diet-induced metabolic parameters without a change in food intake. Male 6-week-old C57BL/6 mice were fed an LF, HF or HF + G diet for 7 weeks (n = 4–5 per group). (A) body weight (g); (B) body weight (%) AUC (BW gain throughout the 7 weeks experiment expressed as % change from week 0 with AUC); (C) food intake (g/day); (D) feeding efficiency ratio (FER, %), calculated as body weight gain (g/day) divided by food intake (g/day); (E) fasting glucose levels (mg/dL); and (F) fasting serum total cholesterol levels (mg/dL). Data are expressed as the mean ± SEM (n = 4–5). Bars with different letters are significantly different according to one-way ANOVA with Bonferroni's comparison test; * $p < 0.05$, ** $p < 0.01$ (LF vs. HF) Figure 4.

Results of the HF+G group showed high levels of the fatty-acid oxidation gene, carnitine palmitoyl transferase 1 (CPT1), which was accompanied by a reduction in adipocyte inflammatory gene expression. This work demonstrated that ginger supplementation attenuated HF-diet-mediated obesity and adipocyte remodeling in C57BL/6 mice.

Ethanolic extract of ginger had reducing impact on the level of blood glucose in rats fed on high fat diet. In addition, ginger ameliorates hyperlipidemia in diabetic rats by decreasing serum cholesterol and serum triglycerides **(Saravanan et al., 2014).** Ginger has appeared to stabilize lipid profiles in high fat diet induced obese rats, 6-gingerol, responsible for the unique taste of ginger has been reported to exhibit anti-inflammatory, antiseptic, and antioxidant activities **(Lee**

et al., 2011), and gingerol and shogaol have been investigated to enhance immunity **(Lu et al., 2011).**

In recent years, various physiological effects, including the antiobesity effects of ginger and several bioactive components in ginger (gingerol and gingerone A etc.) have been revealed in ginger supplementation in vivo **(Sahebkar, 2011).** Furthermore, systematic reviews of recent clinical trials with ginger supplementation reported that ginger supplementation resulted in a remarkable reduction in low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglyceride (TG) levels, as well as an increase in high-density lipoprotein cholesterol (HDL-C) concentration **(Pourmasoumi et al., 2018)**. However, the effect of ginger on adipocyte metabolism in vivo is still unknown.

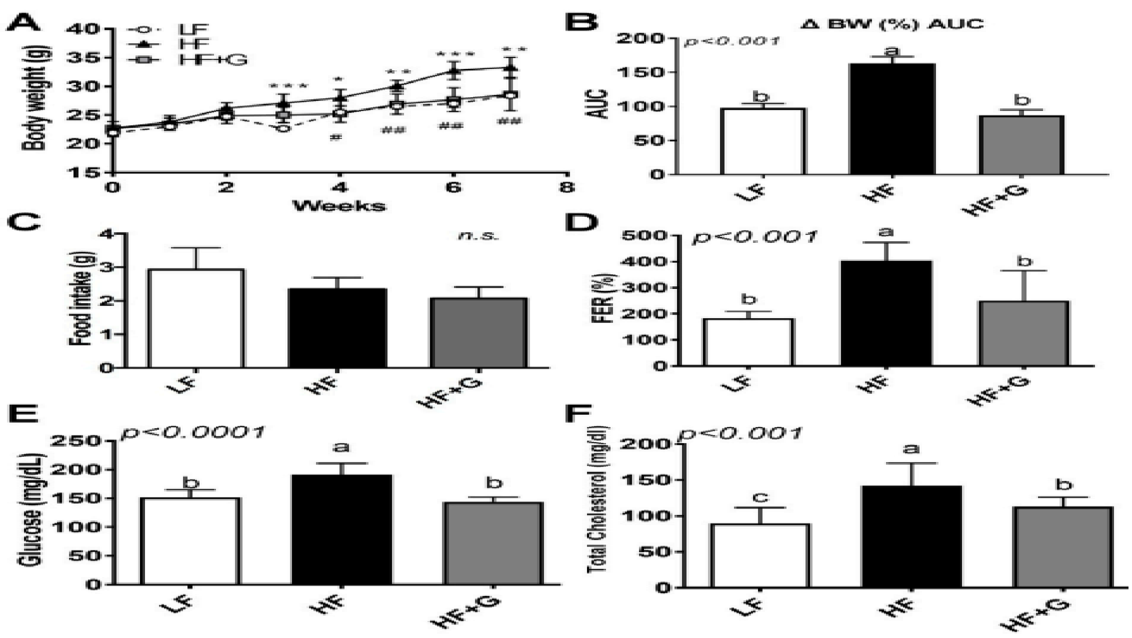

Fig 4 Dietary composition of low fat (LF), high-fat (HF), and HF plus 5%ginger powder (HF+G) diets

Results of the scale applied to adults Compared with placebo, taking dietary ginger resulted in this study **(Taghizadeh et al., 2017).** A significant decrease in weight (–1.8 ± 1.5 vs. +0.4 ± 1.2 kg, respectively, $p < 0.001$) and body mass index (BMI; –0.7 ± 0.5 vs. +0.1 ± 0.5 kg/m 2, respectively, ($p < 0.001$).

In addition, subjects who received green tea, capsaicin and ginger co-supplements had significantly decreased serum insulin concentrations (–2.6 ± 3.9 vs. –0.6 ± 2.0 µIU/mL, p =

0.02), homeo-static model of assessment for insulin resistance (–0.5 ± 0.8 vs. –0.05 ± 0.6, p = 0.01), and increased quantitative insulin sensitivity check index (+0.01 ± 0.01 vs. +0.001 ± 0.01, p = 0.008) and plasma glutathione (GSH) levels (+73.8 ± 120.6 vs. –28.3 ± 193.4 µmol/L, p = 0.03) compared with the placebo indicated that taking , ginger co-supplements for 8 weeks among overweight women had beneficial effects on weight, BMI, markers of insulin metabolism and plasma GSH levels.

Results of the ginger intake increased HDL-cholesterol, but did not affect insulin, BMI, triglycerides, total- and LDL-cholesterol levels.

Several studies have explored the bioactive compounds in ginger and their antioxidant activities, antioxidant compounds rebalance the production of free radicals, subsequently interrupting the oxidative stress mechanism. Besides the extensive medicinal purposes, antioxidants also play a role in food preservation by extending the shelf life of food products. In addition, the most studied compounds in ginger are phenolic compounds, acid-phenols and the antioxidant activity of flavonoids. Apart from that, ginger has been proven as a promising source of health-promoting compounds, such as essential oil, minerals, vitamins and fibers.

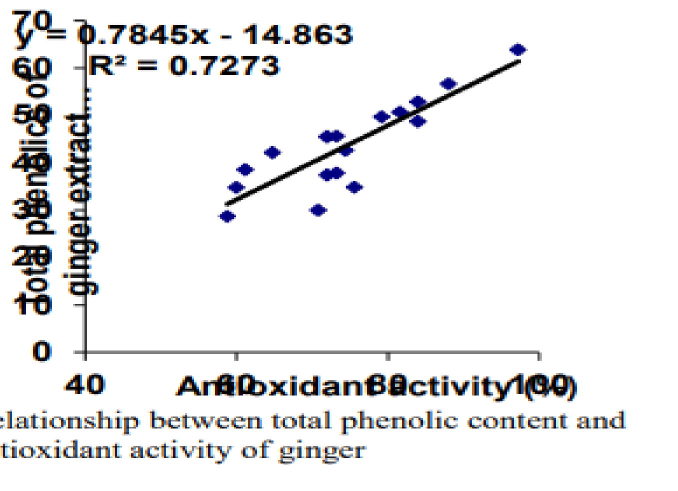

Figure 5: Relationship between total phenolic content and antioxidant activity of ginger

Herbal medicines are plant -derived raw or refined products that are used for the treatment of diseases and obesity effects and decreasing body weight gain with an increase of fecal excretion, **(Moreno, 2006).** A reduction in food intake as a result of reducing appetite and an impacted hormonal status was shown with pomegranate **(Ahmed, 2014).** Ginger (*Zingiber officinale* Rose, Zingiberaceae) is a well -known spice and flavoring material that has also been used in traditional medicine in many areas.

Reduced calorie intake, weight loss and diet plans, as well as increased physical activity, can all help fight obesity. Leptin, the hypothalamic melanocortin 4 receptor, and mitochondrial uncoupling proteins are a few endogenous molecules known to impact body weight. These molecules are prospective targets for the pharmacological treatment of obesity. Sibutramine and orlistat are primarily used to treat adult obesity, which results in a modest 38% weight loss as compared to placebo and other conditions such osteoarthritis, knee and lower back discomfort. Pediatric obesity is influenced by environmental, behavioral (such as the intake of convenient foods), genetic, and familial factors. Reduced calorie intake, weight loss and diet plans, as well as increased physical activity, can all help fight obesity. Natural anti-obesity agents including phenols and flavones, which are abundant in ginger, play a significant effect in lowering the levels of lipid profiles, serum glucose, and liver enzymes.

In type 2 diabetes patients, In addition to improving lipid profile elements and C-Reactive Protein (CRP) and Prostaglandin E2 (PGE2) levels, ginger also increased insulin sensitivity. As a result, ginger may be considered a successful drug for preventing diabetes issues as mention in figure 5.

A systematic review and meta-analysis of clinical trials the meta-analysis includes 12 trials with 586 people in total **(Pourmasoumi et al., 2018)**. According to a combined analysis, using ginger supplements may lower levels of Triacylglycerol (TAG) and low density lipoprotein cholesterol (LDL-C) (4.90 mg/dl and 22.30 to 6.17). Both total cholesterol (TC) and high density lipoprotein cholesterol (HDL-C) were unaffected by ginger (5.13 mg/dl, 95% CI: 11.05 to 0.78; P = 0.089) and neither was HDL-C (2.18 mg/dl, 95% CI: 0.08 to 4.45; P = 0.059). Studies were categorized by the amount of ginger used because inter-study variability was considerable. A substantial decrease in TC (12.26 mg/dl; 95% CI: 22.37 to 2.16) and TAG (38.42 mg/dl; 95% CI: 57.01 to 19.82) was seen in a stratified study **(Tahereh et al., 2014).** In comparison to the placebo group, ginger significantly decreased fasting plasma glucose, HbA1C, insulin, HOMA, triglycerides, total cholesterol, CRP, and PGE2 (p 0.05). Between the two groups, there were no appreciable variations in HDL, LDL, or TNF (p > 0.05). Ginger improved insulin sensitivity, various lipid profile elements, and reduced CRP and PGE2 in people with type 2 diabetes. As a result, ginger may be considered a successful drug for preventing diabetes issues **(Omyma and Mahmoud, 2016).** Adding dried lemon, ginger, and cumin to a high-fat diet decreased body weights as well as significantly lower mean values for serum glucose, total lipid profile, and liver enzymes compared to the positive control groups in all treated groups, while raising high-density lipoprotein levels (HDLc). The findings demonstrated that the dried lemon had the best impact on body weights, lipid profiles, liver function, and glucose levels in obese rats fed a high-fat diet **(Chelsea CourtneyDaniels et al., 2022).** Based on obesity and cardio-metabolic disorders (33.3%), type 2 diabetes mellitus (37.5%), and other illnesses (29.2%), these were evaluated. The effects of Z. officinale were largely positive for total cholesterol and triglyceride levels, but variable for other blood lipid markers.

Z. officinale consistently decreased inflammatory markers C - reactive protein and, Tumor Necrosis Factor (CRP, TNF). Ginger affects adipocyte remodeling. Ginger supplementation effectively reduced HF-mediated adipocyte hypertrophy with elevated lipogenic levels. The fatty-acid oxidation gene, carnitine palmitoyl transferase 1, was also highly expressed in the HF+G group.

CONCLUSION

According to the current systematic review and previous research, ginger has a positive impact on Triacylglycerol (TAG) and Cholesterol -Low Density Lipoprotein (LDL-C). Additionally, the results showed that a low dose of ginger (2 g/day) had a stronger influence on decreasing TAG and TC. Also, ginger has been shown to have an effect on weight as well as on total cholesterol, regardless of LDL OR HDL. Therefore, to verify these findings, more and larger studies should be implemented.

REFERENCES

Abdul Qadir Fadel, rfah Razak Hamid Musa Jassem Himmish. (2017): Chemical and nutritional composition of ginger rhizomes. L officinale. Tikrit Journal of Pure Sciences., 3, 22.

Ahmed, H. G., Ginawi, I. A., Elasbali, A. M., Ashankyty, I. M., & Al-Hazimi, A. M. (2014): Prevalence of obesity in Hail region, KSA: in a comprehensive survey. Journal of obesity, 2014.

Ahmed M.M., Ibrahim Z.S., Alkafafy M., El-Shszzly S.A.L. (2014): -Carnitine protects against testicular dysfunction caused by gamma irradiation in mice. Acta Histochem., 116:1046-1055.

Althumiri, N.A.; Basyouni, M.H.; AlMousa, N.; AlJuwaysim, M.F.; Almubark, R.A.; BinDhim, N.F.; Alkhamaali, Z.; Alqahtani, S.A. (2021): Obesity in Saudi Arabia in 2020: Prevalence, Distribution, and Its Current Association with Various Health Conditions. Healthcare, 9, 311.

Bijaya, B. B., (2018): Ginger Processing in India (Zingiber officinale): A Review; Int.J. Curr.Microbiol.

Blüher, M. (2019): Obesity: Global epidemiology and pathogenesis. Nat. Rev. Endocrinol., 15, 288–298.

Chelsea CourtneyDaniels , ZaiyaanIsaacs, RenataFinelli , KristianLeisegang, October. (2022): Clinical Nutrition ESPEN, 51, 72-82.

Farnaz Shokri, Parvin Mostafa Gharebaghi, Ali Esfahani, Manizheh Sayyah-Melli, Mehri Jafari Shobeiri , Elaheh Ouladsahebmadarek , Morteza Ghojazadeh. (2017): Comparison of the Complications of Platinum-Based Adjuvant Chemotherapy With and Without Ginger in a Pilot Study on Ovarian Cancer Patients, International Journal of Women's Health and Reproduction Sciences., 5(4), 324–331

Fayrouz, A. K., Mokhtar, I. Y., Abdel-Aziz F., Abdel-Aziz., Hanaa, A. H., Kamel, I. k. (2019): Investigation of the effect of ginger on the lipid levels against The Toxic Effect of phthalate in Male Rabbits. EPH - International Journal of Applied Science., 1, 1.

Halima, V; Said, S; Ali, A. A; Seyed Reza, F. T; (2020): The Ginger Supplementation Effects on Aerobic Power Training Capacity and Dysmenorrhea in Overweight Girls. IRANIAN Journal Of Diabetes And Obesity 11, 2.

Kristy Breughel Smith, MD, Michael Seth Smith, MD, CAQ-SM, Phar.D., 2016 Obesity Statistics.

Lee, C., Park, G. H., Kim, C. Y., & Jang, J. H. (2011): Gingerol attenuates β-amyloid-induced oxidative cell death via fortifying cellular antioxidant defense system. Food and chemical toxicology, 49(6), 1261-1269.

Lu, J., Guan, S., Shen, X., Qian, W., Huang, G., Deng, X., & Xie, G. (2011): Immunosuppressive activity of 8-gingerol on immune responses in mice. Molecules, 16(3), 2636-2645.

Luci, C.; Bourinet, M.; Leclère, P.S.; Anty, R.; Gual, P. (2020): Chronic Inflammation in Non-Alcoholic Steatohepatitis: Molecular Mechanisms and Therapeutic Strategies. Front. Endocrinol., 11, 597648. [CrossRef]

Mayo Clinic .(2020): Retrieved from MayoClinic: https://www.mayoclinic.org/ar/diseasesconditions/obesity/symptoms-causes/syc-20375742

Mehrnaz, N. B; Iradj, M; Azita, H; (2018): Ginger in gastrointestinal disorders: A systematic review of clinical trials. Food Science and Nutrition

MOH. (2020): Non-Communicable Diseases - Obesity. Ministry of Health. https://moh.gov.sa/en/HealthAwareness/EducationalContent/Diseases/NonCommunicable /Pa ges/Obesity.aspx.

Moreno D.A .,Iliv N., Poulev A., Raskin I. (2006): Effect of Arachis hypogaea nutshell extract on lipid metabolic enzyme and obesity parameters.Life Sci.;78:2797-2803. Doi:10.1016/j. Ifs.2005.11.012.

Naheed, A., Mahdi, M., Farhad, Sh., Shiva, P., Fatemeh, J., Hajar, T., (2019): The effect of ginger supplementation on IL2, TNFα, and IL1β cytokines gene expression levels in patients with active rheumatoid arthritis: A randomized controlled trial. Med J Islam Repub Iran. 33.154.

Obaroakpo, J.U.; Nan, W.; Hao, L.; Liu, L.; Zhang, S.; Lu, J.; Pang, X.; Lv, J. (2020): The hyperglycemic regulatory effect of sprouted quinoa yoghurt in high-fat-diet and streptozotocin-induced type 2 diabetic mice via glucose and lipid homeostasis. Food Funct., 11, 8354–8368.

Omyma M. ELDarder and M. Y. Mahmoud. (2016): Influence of Dried Lemon, Ginger and Cumin in Weight Reduction and Some Biochemical Parameters in Rats Suffering from Obesity Department of Home Economics, Faculty of Education, Suez Canal University, Egypt, J. Food and Dairy Sci., Mansoura Univ., Vol. 7(11): 471 - 476.

Park, J., H. Hwang, J. Lee. (2006): Quality of ginger powder as affected by concentration and dehydration methods of ginger extracts Korean J. Food Sci. Technol.

Pourmasoumi, M., Hadi, A., Rafie, N., Najafgholizadeh, A., Mohammadi, H., & Rouhani, M. H. (2018): The effect of ginger supplementation on lipid profile: A systematic review and meta-analysis of clinical trials. Phytomedicine, 43, 28-36.

Pushpalatha C. Arshiya Shakir June. (2022): in book: Ginger and its health benefits (pp.29)/ Publisher: Nova publishers / Project: Dentistry. Zaman SB, Hussain MA, Nye R, Mehta V, Mamun KT, et al. A review on antibiotic resistance: alarm bells are ringing. Cureus, 2017; 9(6): e1403.

Sahebkar, A. (2011): Potential efficacy of ginger as a natural supplement for nonalcoholic fatty liver disease. World J. Gastroenterol, 17, 271–272.

Saravanan G., Ponmurugan P.,Deepa M.A., Senthikumar B. (2014): Anti-obesity action of gingerol: Effect on lipid profile ,insulin, leptin, amylase and lipase in male obese rats , induced by high-fat diet. J.Sci.Food Agric.;94:2977.doi:10.1002/jsfa.6642.

Taghizadeh, M., Farzin, N., Taheri, S., Mahlouji, M., Akbari, H., Karamali, F., & Asemi, Z. (2017): The effect of dietary supplements containing green tea, capsaicin and ginger extracts on weight loss and metabolic profiles in overweight women: A randomized double-blind placebo-controlled clinical trial. Annals of Nutrition and Metabolism, 70(4), 277-285.

Tahereh Arablou, Naheed Aryaeian, Majid Valizadeh, Faranak Sharifi, AghaFatemeh Hossein Mahmoud Djalali. (2014): Department of Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences TehranIran Pages 515-520 | Received 14 Oct 2013, Accepted 26 Dec 2013, Published online: 04.

WHO.(2021): Obesity and Overweight. WHO. https://www.who.int/news-room/factsheets/detail/obesity-and-overweight

Yan Liu, Jincheng Liu and Yongqing Zhang. (2019): Research Progress on Chemical Constituents of Zingiber officinale Roscoe; BioMed Research International; Volume 2019